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(54) ILLUMINATOR AND PROJECTION TYPE DISPLAY DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an illuminator whose illuminating efficiency can be enhanced and a projection type display device which provides bright and high- contrast display.

SOLUTION: The illuminator 1 to be used in this projection type display device is provided with an LED array 2 having a plurality of chip LEDs 8R, 8G, 8B, a plurality of tapered rod lenses 3 which are provided in correspondence with respective chip LEDs 8R, 8G, 8B, a rod lens 4 common to the plurality of tapered rod lenses 3 and a light-emission lens 5 for making rays of light entering from the rod lens 4 exit with prescribed outgoing angles.

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CLAIMS

[Claim(s)]

[Claim 1] It is prepared corresponding to the light source which has two or more solid-state light emitting devices, and each of two or more of said solid-state light emitting devices. While incidence of the light from said solid-state light emitting device is carried out from an incidence end face and outgoing radiation is carried out from an outgoing radiation end face, two or more taper-like transparent materials with the larger area of said outgoing radiation end face than the area of said incidence end face, The lighting system characterized by having the optical element to which outgoing radiation of the light by which incidence was carried out is carried out with a predetermined outgoing radiation include angle from said taper-like transparent material.

[Claim 2] The lighting system according to claim 1 characterized by said taper-like transparent material consisting of a transparent material of the shape of a column which a refractive index becomes from one or more ingredients, or a transparent material of the shape of tubing by which the inner surface was made the reflector.

[Claim 3] The lighting system according to claim 1 or 2 characterized by equipping further the outgoing radiation side of said taper-like transparent material with the transparent material which has the function which equalizes the illuminance distribution of incident light.

[Claim 4] The lighting system according to claim 3 with which said transparent material is characterized by considering as the shape of a taper with the larger area of an outgoing radiation end face than the area of an incidence end face.

[Claim 5] The lighting system according to claim 1 or 2 characterized by equipping the outgoing radiation side of each of said taper-like transparent material with said optical element, respectively.

[Claim 6] The lighting system according to claim 5 characterized by for the outgoing radiation light from said each optical element having a predetermined outgoing radiation include angle, and superimposing a part on the outgoing radiation light from two or more optical elements at least in an illuminated field.

[Claim 7] The lighting system according to claim 5 or 6 characterized by arranging said optical element corresponding to said solid-state light emitting device in the location from which it separated from a system optical axis in the location of said system optical-axis approach to the outgoing radiation optical axis of said solid-state light emitting device.

[Claim 8] The lighting system according to claim 5 or 6 characterized by arranging said two or more solid-state light emitting devices so that each outgoing radiation optical axis may cross.

[Claim 9] A lighting system given in claim 1 characterized by preparing the closure layer of said solid-state light emitting device which has translucency in an outgoing radiation side at least thru/or any 1 term of 8.

[Claim 10] The lighting system according to claim 9 with which the side face of said closure layer is characterized by considering as the taper configuration of a point flare towards the direction of outgoing radiation of light.

[Claim 11] The lighting system according to claim 10 characterized by making the side face of said closure layer into the reflector which reflects in said closure layer side the light which carried out the light guide of the interior of said closure layer, and reached said side face.

[Claim 12] A lighting system given in claim 1 characterized by preparing said two or more solid-state light emitting devices in the whole surface of a substrate thru/or any 1 term of 11.

[Claim 13] The lighting system according to claim 12 characterized by drawing the external terminal of said solid-state light emitting device through the through

hole which said two or more solid-state light emitting devices are mounted in the whole surface of said substrate, and penetrates said substrate to the solid-state light emitting device component side of said substrate, and the field of an opposite hand.

[Claim 14] The lighting system according to claim 13 characterized by preparing the conductor which forms some external terminals of said solid-state light emitting device in said component side of said substrate, and covering said conductor by the insulator layer.

[Claim 15] The lighting system according to claim 14 characterized by preparing said taper-like transparent material on said insulator layer.

[Claim 16] A lighting system given in claim 1 characterized by including the solid-state light emitting device to which two or more solid-state light emitting devices which constitute said light source emit light in the colored light of a different color thru/or any 1 term of 15.

[Claim 17] The projection mold display characterized by equipping claim 1 thru/or any 1 term of 16 with the lighting system of a publication, the optical modulator which modulates the light from said lighting system, and the projector lens which projects the light modulated by said optical modulator at least.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a lighting system and a projection mold display.

[0002]

[Description of the Prior Art] Image light is compounded using optical modulators, such as a liquid crystal light valve, and the projection mold display which carries

out amplification projection of the compounded image light at a screen through the incident light study system which consists of a projector lens etc. is known from the former. In the lighting system used for this kind of projection mold display, the light by which outgoing radiation is carried out from the light source of a metal halide lamp etc. is usually bright in a center section, and it has the uneven illuminance distribution that the periphery section is dark. So, the lighting system for projection mold indicating equipments is usually equipped with homogeneity illumination systems, such as a fly eye integrator which consists of a fly eye lens of two sheets, or a rod integrator which consists of a rod-like transparent material (it may be hereafter called a rod lens), in order to specifically equalize an illuminated field and the illuminance distribution in a liquid crystal light valve. Moreover, adoption of the field luminescence light source from which an illuminance with the light source uniform in a field itself is easy to be obtained is considered.

[0003]

[Problem(s) to be Solved by the Invention] In order to have realized the field luminescence light source conventionally, the so-called LED lamp array which arranged two or more light emitting diode (it is written as LED Light Emitting Diode and the following) lamps in in the shape of an array on the substrate was offered. However, each LED was equipped with the resin lens which projected in the shape of a semi-sphere, and the conventional LED lamp had become what has the quite large-sized light source itself, when this was arranged in in the shape of an array. On the other hand, LED (Chip LED is called hereafter) of a chip mold is offered, and, thereby, miniaturization of the light source and thin shape-ization can be attained now in recent years.

[0004] However, since Chip LED had the property that radiation angular distribution is large, when it illuminated the illuminated body, it had the problem that lighting effectiveness was bad. Moreover, since there were many components of the light which carries out incidence from across to the plane of incidence of optical modulators, such as a liquid crystal light valve, when it uses

for a projection mold indicating equipment, the display became dark and it had become the cause that contrast falls.

[0005] This invention is made in order to solve the above-mentioned technical problem, and it aims at offering the lighting system which can aim at improvement in lighting effectiveness. Moreover, it is bright and aims at offering the projection mold display with which the display of high contrast is obtained.

[0006]

[Means for Solving the Problem] In order to attain the above-mentioned object, the lighting system of this invention It is prepared corresponding to the light source which has two or more solid-state light emitting devices, and each of two or more of said solid-state light emitting devices. While incidence of the light from said solid-state light emitting device is carried out from an incidence end face and outgoing radiation is carried out from an outgoing radiation end face, two or more taper-like transparent materials with the larger area of said outgoing radiation end face than the area of said incidence end face, It is characterized by having the optical element to which outgoing radiation of the light by which incidence was carried out is carried out with a predetermined outgoing radiation include angle from said taper-like transparent material.

[0007] Although the field luminescence light source is constituted by the light source in which the lighting system of this invention has two or more solid-state light emitting devices, since the radiation angular distribution of the solid-state light emitting device itself is large, the light-emission angular distribution by which outgoing radiation is carried out from there only by this light source is still large. However, in this invention, since the outgoing radiation side of the light source is equipped with said taper-like transparent material, in case the light from a solid-state light emitting device reflects inside a taper-like transparent material, it will be bent to a system optical axis by the include angle near parallel, and radiation angular distribution can be narrowed. Furthermore, since the outgoing radiation side of a taper-like transparent material is equipped with said optical element, outgoing radiation of the light by which incidence was carried out is carried out

with a predetermined outgoing radiation include angle from a taper-like transparent material, to an illuminated field predetermined by adjusting the outgoing radiation include angle suitably, it is efficient and more uniform lighting can be realized. In addition, a "system optical axis" is an outgoing radiation optical axis as the whole lighting system.

[0008] Said taper-like transparent material can consist of a transparent material of the shape of a column which a refractive index becomes from one or more ingredients, or a transparent material of the shape of tubing by which the inner surface was made the reflector. The "column-like transparent material" or "the tubing-like transparent material by which the inner surface was made the reflector" said here is a certain rod lens from the so-called former. According to this configuration, the configuration of this invention is easily realizable only by installing the conventional rod lens in the outgoing radiation side of said light source.

[0009] Moreover, the outgoing radiation side of said taper-like transparent material may be further equipped with the transparent material which has the function which equalizes the illuminance distribution of incident light. In that case, it is good also considering said transparent material as the shape of a taper with the larger area of an outgoing radiation end face than the area of an incidence end face. In this invention, although light-emission angular distribution can be narrowed by the taper-like transparent material, illuminance distribution can be equalized more by equipping the outgoing radiation side with said transparent material. When it uses as a lighting system of the result, for example, a display, the brightness nonuniformity of a display can be controlled. It becomes possible to heighten more the effectiveness which narrows radiation angular distribution, maintaining the effectiveness of equalization of this transparent material of the shape of a taper then, and illuminance distribution furthermore.

[0010] When preparing said optical element in the outgoing radiation side of said taper-like transparent material, one optical element may be prepared to two or more taper-like transparent materials, and an optical element may be prepared in

each taper-like transparent material, respectively. Especially in the case of the latter, an outgoing radiation include angle can be controlled for every flux of light by which outgoing radiation is carried out from each solid-state light emitting device, and more efficient lighting can be performed.

[0011] When an optical element is especially prepared for every taper-like transparent material, it is desirable to consider as the configuration which the outgoing radiation light from each optical element has a predetermined outgoing radiation include angle, and is superimposed on the outgoing radiation light from two or more optical elements in part at least in an illuminated field. Though each outgoing radiation light of a center is bright by considering as the configuration superimposed on the outgoing radiation light from two or more optical elements in part in an illuminated field and it has the illuminance distribution that it is dark in the circumference, the illuminance distribution is offset and the illumination light with an illuminance uniform as a whole can be obtained. Furthermore, even when there is variation in brightness between the configuration altogether superimposed on the outgoing radiation light from two or more optical elements in an illuminated field, then outgoing radiation light, the variation is offset, and the illumination light without illuminance nonuniformity can be obtained.

[0012] Moreover, as for the optical element corresponding to the solid-state light emitting device in the location from which it separated from the system optical axis, it is desirable to arrange in the location of system optical-axis approach to the outgoing radiation optical axis of a solid-state light emitting device. According to this configuration, since the sense of the outgoing radiation optical axis from an optical element approaches system optical-axis approach, i.e., the main approach of an illuminated field, there is no futility of light and more efficient lighting can be offered.

[0013] Or it is desirable to arrange two or more solid-state light emitting devices in the shape of a curved surface so that for example, an illuminated field may be surrounded, and to constitute so that each outgoing radiation optical axis may cross. If the crossing of each outgoing radiation optical axis is located at the core

of an illuminated field when it considers as this configuration, like the above-mentioned case, there is no futility of light and more efficient lighting can be offered.

[0014] Furthermore, the closure layer of a solid-state light emitting device which has translucency in an outgoing radiation side at least may be prepared. According to this configuration, by having prepared the closure layer, the outgoing radiation side of a solid-state light emitting device can be protected, for example from a mechanical impact, encroachment of moisture, etc., and dependability can be improved.

[0015] As for the side face of said closure layer, it is desirable to consider as the taper configuration of a point flare towards the direction of outgoing radiation of light. In that case, it is desirable to consider as the reflector which reflects in a closure layer side further the light which reached [side face / of a closure layer] the side face of light guide Perilla frutescens (L.) Britton var. crispa (Thunb.) Decne. in the interior of a closure layer. Since the closure layer has translucency, trouble does not arise in the outgoing radiation of light fundamentally, but since the radiation angular distribution of a solid-state light emitting device is large, there is a possibility that total reflection may be carried out on the front face of a closure layer about the light which carried out outgoing radiation at the large radiation include angle, and outgoing radiation may not be carried out outside. If this is the taper configuration of a point flare towards the direction of outgoing radiation of light and it is a reflector further, when such a light carries out the light guide of the interior of a closure layer and reaches the side face of a closure layer, since said light will be changed and reflected in a more nearly vertically near outgoing radiation include angle to the front face of a closure layer, the outgoing radiation of the light can be made to be able to carry out outside, and it can be made to contribute to lighting.

[0016] Although two or more solid-state light emitting devices may be accumulated with what kind of gestalt, it can consider as the configuration which installs two or more solid-state light emitting devices in the whole surface of a

substrate, for example using the substrate of arbitration. According to this configuration, two or more solid-state light emitting devices can be accumulated easily, and the handling of the light source also becomes easy.

[0017] When two or more solid-state light emitting devices are mounted in the whole surface of a substrate, it is desirable to consider as the configuration from which the external terminal of a solid-state light emitting device was drawn by the solid-state light emitting device component side of a substrate and the field of an opposite hand through the through hole which penetrates a substrate. The mounting gestalt of the conventional solid-state light emitting device was drawing the terminal to the exterior of a solid-state light emitting device body using wire bonding etc. on the component side while mounting the body of a solid-state light emitting device in the substrate etc. In case of this gestalt, the tooth space for wire bonding is required for the perimeter of the body of a solid-state light emitting device, and a wire and a taper-like transparent material may interfere, and trouble may arise in installation of a taper-like transparent material. On the other hand, since the external terminal of a solid-state light emitting device is drawn through the through hole to the solid-state light emitting device component side of a substrate, and the field of an opposite hand, while according to the above-mentioned configuration wire bonding on a component side becomes unnecessary and a mounting activity becomes easy, a taper-like transparent material can be installed convenient.

[0018] When the conductor which forms some external terminals of a solid-state light emitting device is prepared in the component side of a substrate, it is desirable to consider said conductor as a wrap configuration by the insulator layer. In that case, a taper-like transparent material can be prepared on an insulator layer. According to this configuration, the conductor which forms some external terminals can prevent the nonconformity of connecting with other members too hastily. Thereby, a taper-like transparent material can be prepared on an insulator layer, for example, if it is a tubing-like taper-like transparent material, since this can be made to be able to approach a solid-state light

emitting device and it can install, the utilization effectiveness of the outgoing radiation light from a solid-state light emitting device can be raised.

[0019] In the lighting system of this invention, it is good also as a configuration containing the solid-state light emitting device to which two or more solid-state light emitting devices which constitute the light source emit light in the colored light of a different color. according to this configuration -- a color order -- it can be used as a lighting system of the color projection mold display of an actuation [degree] (color -- sequential) method. In that case, unlike the projection mold indicating equipment of 3 conventional plate methods using three light valves for every colored light, a light valve can be managed with one piece (it becomes a veneer method), and a lighting system can also be further managed with one line. And since color separation optical system and color composition optical system become unnecessary, while components mark are greatly reducible, an equipment configuration can be simplified, and cost reduction can be planned.

[0020] The projection mold display of this invention is characterized by having at least the lighting system of above-mentioned this invention, the optical modulator which modulates the light from said lighting system, and the projector lens which projects the light modulated by said optical modulator. According to this configuration, a lighting system to radiation angular distribution is narrow by having had the lighting system of above-mentioned this invention, and since the light by which illuminance distribution was equalized is irradiated, there is little brightness nonuniformity and it can reproduce the image of high contrast.

[0021]

[Embodiment of the Invention] The lighting system of the 1st operation gestalt of this invention is explained with reference to drawing 1 below [the lighting system of the 1st operation gestalt]. The gestalt of this operation shows the example using Chip LED as a solid-state light emitting device which constitutes the light source. Drawing 1 is the schematic diagram showing the whole lighting-system 1 configuration, and, for the sign 2 in drawing, as for a taper rod lens (taper-like transparent material) and 4, an LED array (light source) and 3 are [a rod lens

(transparent material) and 5] outgoing radiation lenses (optical element). In addition, a sign 6 shows the liquid crystal light valve (optical modulator) used as the illuminated body.

[0022] As the lighting system 1 of the gestalt of this operation is shown in drawing 1 , the chip 8R, 8G, and LED 8B of plurality (drawing 1 shows only three pieces) is mounted on the whole surface of the substrate 7 of arbitration, such as a printed circuit board, and LED array 2 is constituted. The gestalt of next operation explains the mounting gestalt of Chip 8R, 8G, and LED 8B. It is carried on the LEDwhich can emit light in colored light of R (red) as chip LED 8 substrate 7 of eight B1 LED which can emit light in the colored light of LED8G and B (blue) which can emit light in the colored light of R and G (green).

[0023] And to one chip 8R, 8G, and LED 8B, one taper rod lens 3 corresponds and is prepared. With the gestalt of this operation, the taper rod lens 3 which consists of a mirror of the shape of tubing arranged so that an inner surface may turn into a reflector is used. In addition, the taper rod lens which a refractive index becomes from the pillar-shaped object of one or more ingredients, for example, glass etc., may be used. In drawing 2 , the field on the left-hand side of the taper rod lens 3 is outgoing radiation end-face 3b, and, as for the taper rod lens 3, the field of incidence end-face 3a and right-hand side serves as a configuration of the shape of a taper of a point flare from the incidence end-face 3a side towards the outgoing radiation end-face 3b side.

[0024] One rod lens 4 is formed in the outgoing radiation side of two or more taper rod lenses 3. The rod lens 4 is also constituted from the mirror of the shape of tubing by which the inner surface has been arranged so that it may become a reflector by the gestalt of this operation. And direct continuation of the mirror of the outermost periphery of two or more taper rod lenses 3 and the mirror of a rod lens 4 is carried out. Furthermore, the outgoing radiation lens 5 which consists of the usual convex lens is formed in the location estranged from the rod lens 4 by the side of rod-lens 4 outgoing radiation.

[0025] In the lighting system 1 of the gestalt of this operation, since the outgoing

radiation side of LED array 2 which has two or more chips 8R, 8G, and LED 8B is equipped with the taper rod lens 3, while the light from Chip 8R, 8G, and LED 8B carries out the light guide of the interior of the taper rod lens 3, it reflects inside, and the light L of the include angle near parallel is obtained to the system optical axis S, and radiation angular distribution can be narrowed. And since the outgoing radiation side of the taper rod lens 3 is equipped with the rod lens 4, illuminance distribution can be equalized. Furthermore, since the outgoing radiation side of a rod lens 4 is equipped with the outgoing radiation lens 5, outgoing radiation of the light by which incidence was carried out is carried out to the outgoing radiation lens 5 with a predetermined outgoing radiation include angle, it is efficient to the liquid crystal light valve 6 by adjusting the outgoing radiation include angle suitably, and uniform lighting can be realized. When it uses as a lighting system of the result, for example, a projection mold display, control of improvement in lighting effectiveness, improvement in contrast, and the brightness nonuniformity of a display can be aimed at.

[0026] Moreover, when the outer diameter of the outgoing radiation end face of a rod lens 4 is small set up to the outer diameter of the liquid crystal light valve 6 used as the illuminated body and it considers as an amplification illumination-light study system, since the incidence include angle at the time of light carrying out incidence to the liquid crystal light valve 6 is in inverse proportion to a dilation ratio, it can make small the incidence include angle to the liquid crystal light valve 6, and carries out improvement in contrast nearby at that lighting effectiveness improves more and coincidence.

[0027] The lighting system of the 2nd operation gestalt of this invention is explained with reference to drawing 2 - drawing 4 below [the lighting system of the 2nd operation gestalt]. Although drawing 2 is the schematic diagram showing the whole lighting-system configuration of this operation gestalt, the same sign is given to the same component as the 1st operation gestalt, and detailed explanation is omitted.

[0028] As the lighting system 11 of this operation gestalt is shown in drawing 2 ,

two or more chips 8R, 8G, and LED 8B are mounted on the whole surface of a substrate 7, and LED array 2 is constituted. And to one chip 8R, 8G, and LED 8B, one taper rod lens 3 corresponds and is prepared. The configuration so far is the same as that of the 1st operation gestalt almost. With the 1st operation gestalt, the outgoing radiation lens 12 which there is no rod lens and becomes the outgoing radiation end face of each taper rod lens 3 from the usual convex lens is directly installed in the outgoing radiation side of the taper rod lens 3 by this operation gestalt to sequential installation of a rod lens 4 and the outgoing radiation lens 5 having been carried out. Air may exist and, as for the building envelope of the taper rod lens 3, you may fill up with the ingredient of a low refractive index rather than the outgoing radiation lens 12. And the outgoing radiation include angle of the outgoing radiation light L from each outgoing radiation lens 12 is set up so that all may be superimposed on the outgoing radiation light L by which outgoing radiation is carried out from each outgoing radiation lens 12 on the whole surface of the liquid crystal light valve 6.

[0029] Also in this operation gestalt, when it is efficient, and uniform lighting can be realized to the liquid crystal light valve 6, for example, it uses as a lighting system of a projection mold display, the same effectiveness as the 1st operation gestalt that control of improvement in contrast and the brightness nonuniformity of a display can be aimed at can be acquired.

[0030] Since the outgoing radiation lens 12 is furthermore formed in each taper rod lens 3, respectively in the case of the gestalt of this operation, an outgoing radiation include angle can be controlled for every flux of light by which outgoing radiation is carried out from each chip 8R, 8G, and LED 8B, and more efficient lighting can be performed. Since all are specifically superimposed on the outgoing radiation light by which outgoing radiation is carried out on the whole surface of the liquid crystal light valve 6 from each outgoing radiation lens 12 For example, what is necessary is just to arrange the core C1 of the outgoing radiation lenses 12R and 12B corresponding to the chips 8R and LED 8B in the location from which it separated from the system optical axis S in the location of

system optical-axis S approach to the outgoing radiation optical axis C2 of each chips 8R and LED 8B, as shown in drawing 3 . Or as shown in drawing 4 , two or more chips 8R, 8G, and LED 8B may be arranged in the shape of a curved surface so that the liquid crystal light valve 6 may be surrounded, and you may constitute so that the outgoing radiation optical axis C3 from each chip 8R, 8G, and LED 8B may cross focusing on the abbreviation for the liquid crystal light valve 6. Although it can be bright in the center of each outgoing radiation light and it can offset the illuminance distribution that it is dark in the circumference, only by a part being superimposed on the outgoing radiation light from two or more chips 8R, 8G, and LED 8B on the liquid crystal light valve 6 Since all are superimposed on the outgoing radiation light from two or more chips 8R, 8G, and LED 8B on the liquid crystal light valve 6 in the case of the gestalt of this operation, even when there is brightness variation between two or more chips 8R and LED 8G and 8B, the variation is offset, and the illumination light without illuminance nonuniformity can be obtained.

[0031] The lighting system of the 3rd operation gestalt of this invention is explained with reference to drawing 5 - drawing 9 below [the lighting system of the 3rd operation gestalt]. Although drawing 5 is the schematic diagram showing the whole lighting-system configuration of this operation gestalt, the same sign is given to the same component as the 1st operation gestalt, and detailed explanation is omitted.

[0032] As the lighting system 17 of this operation gestalt is shown in drawing 5 , two or more chips 8R, 8G, and LED 8B are mounted on the whole surface of a substrate 7, and LED array 2 is constituted. And two or more chips 8R, 8G, and LED 8B are closed with the ingredient which has the translucency of acrylic resin etc., and the closure layer 18 is formed. Side-face 18a of the closure layer 18 is a plane, and is made into the taper configuration of a point flare towards the direction of outgoing radiation of light, and the mirror 19 by which the inner surface was made the reflector is installed in side-face 18a.

[0033] Since the closure layer 18 has translucency in the case of this operation

gestalt, trouble does not arise in the outgoing radiation of light fundamentally. However, since the radiation angular distribution of Chip 8R, 8G, and LED 8B is large, there is a possibility that total reflection may be carried out on the front face of the closure layer 18 about the light which carried out outgoing radiation at the large radiation include angle, and outgoing radiation may not be carried out to the exterior of the closure layer 18. since light be change into a more nearly vertically near outgoing radiation include angle to the front face of the closure layer 18 as the arrow head of a sign L1 show , since the side face of the closure layer 18 be the taper configuration of a point flare and be a reflector by the mirror 19 further towards the direction of outgoing radiation of light as this cure , outgoing radiation can be carry out to the exterior of the closure layer 18 , and it can contribute to lighting .

[0034] Although side-face 18a of the closure layer 18 was made into the plane in drawing 5 , as it replaces with this configuration and is shown in drawing 6 , it is good also considering side-face 18b of the closure layer 18 as the shape of a curved surface. Thus, the outgoing radiation include angle to the closure layer exterior of light reflected on the side face of the closure layer 18 can be adjusted suitably.

[0035] Moreover, as shown in drawing 7 , the taper rod lens 24 may be further added to the outgoing radiation side of the closure layer 18 of the lighting system 17 shown in drawing 5 . Thereby, the outgoing radiation light-emission angular distribution from this lighting system 23 can be narrowed more. Moreover, as shown in drawing 8 , the outgoing radiation lens 26 may be directly installed in the outgoing radiation side of the taper rod lens 24 of the lighting system 23 shown in drawing 7 , and as shown in drawing 9 , a rod lens 28 may be installed directly.

[0036] The lighting system of the 4th operation gestalt of this invention is explained with reference to drawing 10 and drawing 11 below [the lighting system of the 4th operation gestalt]. Although the above-mentioned operation gestalt explained the whole lighting-system configuration, this operation gestalt explains

the mounting structure of Chip LED. Drawing 10 is the sectional view showing the mounting structure of the chip LED of this operation gestalt.

[0037] As the mounting structure of the chip LED 8 of this operation gestalt is shown in drawing 10 , chip LED body 8a of a surface mount mold is mounted in the top face of a substrate 7 so that an upside and an electrode forming face may serve as [an optical outgoing radiation side] the bottom. Conductor patterns 29a and 29b are formed in a top face and an underside like a double-sided printed wiring board, and the substrate 7 in the gestalt of this operation is electrically connected through the through hole 30 where these conductor patterns 29a and 29b penetrate a substrate 7. And the positive electrode and negative electrode by the side of a chip LED body 8a underside are connected to two conductor pattern 29a of substrate 7 top face, respectively. The external terminal of a chip LED 8 is drawn with the component side of a substrate 7 by this configuration in the field of an opposite hand. Moreover, conductor pattern 29a on the top face of a substrate is covered by the insulator layers 31, such as resist film, and the taper rod lens 3 is installed on the insulator layer 31.

[0038] The mounting gestalt of the conventional chip LED was drawing the external terminal from the electrode using wire bonding etc. on the component side while mounting the chip LED body in the substrate etc. In case of this gestalt, the tooth space for wire bonding is required for the perimeter of a chip LED body, and trouble may arise in installation of a taper rod lens. On the other hand, according to the configuration of this operation gestalt, since the external terminal is drawn through the through hole 30 to the component side of the chip LED 8 of a substrate 7, and the field of an opposite hand, wire bonding on a component side becomes unnecessary, and can attain high-density-assembly-ization. Moreover, conductor pattern 29a preventing the nonconformity of connecting with other members or taper rod-lens 3 self too hastily, since conductor pattern 29a on the top face of a substrate is covered by the insulator layer 31 and has formed the taper rod lens 3 on the insulator layer 31, the taper rod lens 3 can be made to be able to approach a chip LED 8, and can be installed. Consequently, the

utilization effectiveness of the outgoing radiation light from a chip LED 8 can be raised.

[0039] Moreover, you may make it cover in the same closure layer 18, as shown in drawing 11 as drawing 5 - drawing 9 showed the chip LED 8 of the lighting system 33 shown by drawing 10 , and the top face of an insulator layer 31. Thereby, a chip LED 8 and conductor pattern 29a can be protected certainly.

[0040] In addition, the technical range of this invention can add various modification in the range which is not limited to the gestalt of the above-mentioned implementation and does not deviate from the meaning of this invention. For example, although LED was used with the above-mentioned operation gestalt as a solid-state light emitting device which constitutes the light source, semiconductor laser, an electroluminescent element, etc. can be used. Moreover, although the usual convex lens was used as an optical element which controls the outgoing radiation include angle to the illuminated body, aspheric lenses, such as the Fresnel zone plate, a hologram, a diffraction component, etc. can be used.

[0041] The projection mold display of the 1st operation gestalt of this invention is explained with reference to drawing 12 below [the projection mold display of the 1st operation gestalt]. The projection mold indicating equipment of this operation gestalt is the example of the transparency mold liquid crystal projector which used the transparency mold liquid crystal light valve as an optical modulator. Drawing 12 is the outline block diagram of the liquid crystal projector of this operation gestalt.

[0042] The liquid crystal projector 41 of this operation gestalt has the 1st lighting system 1 and liquid crystal light valve 6 of an operation gestalt which were shown in drawing 1 , as shown in drawing 12 . Namely, LED array 2 by which two or more chips 8R, 8G, and LED 8B in which outgoing radiation is possible were arranged by the plane in each colored light of R, G, and B, Two or more taper rod lenses 3 installed corresponding to Chip 8R, 8G, and LED 8B, The rod lens 4 prepared in common to two or more taper rod lenses 3, The outline configuration

is carried out from the outgoing radiation lens 5, the liquid crystal light valve 6 which modulates each colored light by which incidence is carried out from the outgoing radiation lens 5, and compounds an image, and the projector lens 44 which carries out amplification projection of the image compounded with the liquid crystal light valve 6 at a screen 43. In addition, in order to raise the utilization effectiveness of light more, it is good also as a configuration equipped with the PBS (polarization beam splitter) array which arranges the light from Chip 8R, 8G, and LED 8B with the polarization used for a display with the liquid crystal light valve 6.

[0043] It connects with the light source actuation circuit which is not illustrated, the timing to which each LED 8R, 8G, and 8B emits light is controlled by this light source actuation circuit, and LED array 2 has composition which can emit light in colored light like R, G, B, R, G, B, and -- from each LED 8R, 8G, and 8B time amount sequential.

[0044] The liquid crystal cell 45 of the transparency mold of the active matrix in TN mode which used the thin film transistor (it is written as TFT Thin Film Transistor and the following) as a component for pixel switching is used for the liquid crystal light valve 6, it is arranged and the incidence side polarizing plate 46 and the outgoing radiation side polarizing plate 47 are formed for the transparency shaft in the outside surface of a liquid crystal cell 45 so that it may intersect perpendicularly mutually. For example, while outgoing radiation of the s-polarized light by which incidence was carried out to the liquid crystal light valve 6 in the OFF state is changed and carried out to p-polarized light, light is intercepted in an ON state.

[0045] The liquid crystal light valve 6 is connected to the liquid crystal light valve actuation circuit which is not illustrated, and it has structure which it is made to correspond to each colored light by which incidence is carried out in this liquid crystal light valve actuation circuit, and can drive the liquid crystal light valve 6 to time amount sequential. Moreover, it sets to the projection mold display 41 of the gestalt of this operation. It has the synchronizing signal generating circuit which

is not illustrated. By this synchronizing signal generating circuit It has the structure where the timing which carries out outgoing radiation of the colored light, and the timing which drives the liquid crystal light valve 6 corresponding to the colored light can be synchronized from each LED 8R, 8G, and 8B by generating a synchronizing signal and inputting into a light source actuation circuit and a liquid crystal light valve actuation circuit.

[0046] namely, in the projection mold display 41 of the gestalt of this operation Time sharing of the one frame is carried out. From LED 7r, 7g, and 7b to time amount sequential R, By synchronizing the timing which is made to carry out outgoing radiation of each colored light of G and B, and carries out outgoing radiation of the colored light from each LED 7r, 7g, and 7b, and the timing which drives the liquid crystal light valve 5 It is made to correspond to the colored light by which outgoing radiation is carried out from each LED 7r, 7g, and 7b, the liquid crystal light valve 5 is driven to time amount sequential, and it has composition which can compound a color picture by outputting the picture signal corresponding to the colored light by which outgoing radiation is carried out from each LED 7r, 7g, and 7b.

[0047] the projection mold display 41 of the gestalt of this operation -- the so-called "color order -- the actuation method called actuation [degree] (color -- sequential) method" is adopted. Therefore, unlike the projection mold indicating equipment of 3 conventional plate methods using three liquid crystal light valves for every colored light, the liquid crystal light valve 6 can be managed with one piece (it becomes a veneer method), and the lighting system 1 to the liquid crystal light valve 6 can also be further managed with one line. And since color separation optical system and color composition optical system become unnecessary, while components mark are greatly reducible, an equipment configuration can be simplified, and cost reduction can be planned. Moreover, a lighting system 1 to radiation angular distribution is narrow, and since the light by which illuminance distribution was equalized is irradiated by the liquid crystal light valve 6, there is little brightness nonuniformity and it can reproduce the image of

high contrast.

[0048] The projection mold display of the 2nd operation gestalt of this invention is explained with reference to drawing 13 below [the projection mold display of the 2nd operation gestalt]. The projection mold indicating equipment of this operation gestalt is the example of the reflective mold liquid crystal projector which used the high-reflective-liquid-crystal light valve as an optical modulator. Drawing 13 is the outline block diagram of the liquid crystal projector of this operation gestalt.

[0049] The liquid crystal projector 51 of this operation gestalt has the 2nd lighting system 11 and liquid crystal light valve 52 of an operation gestalt which were shown in drawing 2 , as shown in drawing 13 . Namely, LED array 2 by which two or more chips 8R, 8G, and LED 8B in which outgoing radiation is possible were arranged by the plane in each colored light of R, G, and B, Two or more taper rod lenses 3 installed corresponding to Chip 8R, 8G, and LED 8B, The outgoing radiation lens 12 prepared in the outgoing radiation end face of each taper rod lens 3, The outline configuration is carried out from the liquid crystal light valve 52 which modulates each colored light by which incidence is carried out from the outgoing radiation lens 12, and compounds an image, and the projector lens 44 which carries out amplification projection of the image compounded with the liquid crystal light valve 52 at a screen 43. The reflective mold liquid crystal cell 53 of the active matrix in TN mode which used TFT is used for the liquid crystal light valve 52, and the polarizing plate 54 is formed.

[0050] Also in the liquid crystal projector 51 of this operation gestalt, the same effectiveness as the liquid crystal projector of the 1st operation gestalt that there is little brightness nonuniformity by having had the lighting system 11 of the above-mentioned operation gestalt, and the image of high contrast can be reproduced can be acquired.

[0051] In addition, the technical range of this invention can add various modification in the range which is not limited to the gestalt of the above-mentioned implementation and does not deviate from the meaning of this invention. For example, although the example of the liquid crystal projector of

color sequential actuation of a veneer method which made red light, green light, and blue glow LED in which outgoing radiation is possible intermingled was given into one lighting system with the gestalt of the above-mentioned implementation, it is good also as a liquid crystal projector of 3 plate methods which formed the lighting system in which outgoing radiation is possible for red light, green light, and three blue glow, and were equipped with color composition optical system, such as a cross dichroic prism. Or it is good also as a liquid crystal projector of 3 plate type which was equipped with one lighting system in which outgoing radiation is possible for the white light, and was equipped with color composition optical system, such as color separation optical system, such as a dichroic mirror, and a cross dichroic prism. Furthermore, although the above-mentioned operation gestalt showed the example which used the lighting system of this invention for the projection mold display, it can also use for the display of a direct viewing type.

[0052]

[Effect of the Invention] As mentioned above, as explained to the detail, according to the lighting system of this invention, to an illuminated field, it is efficient and more uniform lighting can be realized. Moreover, according to the projection mold display of this invention, a lighting system to radiation angular distribution is narrow, and since the light by which illuminance distribution was equalized is irradiated, there is little brightness nonuniformity and it can reproduce the image of high contrast.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the outline block diagram showing the lighting system of the 1st operation gestalt of this invention.

[Drawing 2] It is the outline block diagram showing the lighting system of the 2nd operation gestalt of this invention.

[Drawing 3] It is the outline block diagram showing the modification of the outgoing radiation lens of a **** lighting system.

[Drawing 4] It is the outline block diagram showing the modification of arrangement of the chip LED of a **** lighting system.

[Drawing 5] It is the outline block diagram showing the lighting system of the 3rd operation gestalt of this invention.

[Drawing 6] It is the outline block diagram showing the modification of the side-face configuration of the closure layer of a **** lighting system.

[Drawing 7] It is the outline block diagram showing the modification of a **** lighting system.

[Drawing 8] It is the outline block diagram showing the modification of a **** lighting system.

[Drawing 9] It is the outline block diagram showing the modification of a **** lighting system.

[Drawing 10] It is the outline block diagram showing the lighting system of the 4th operation gestalt of this invention.

[Drawing 11] It is the outline block diagram showing the modification of a **** lighting system.

[Drawing 12] It is the outline block diagram of the liquid crystal projector which is the projection mold indicating equipment of the 1st operation gestalt of this invention.

[Drawing 13] It is the outline block diagram of the liquid crystal projector which is the projection mold indicating equipment of the 2nd operation gestalt of this invention.

[Description of Notations]

1, 11, 13, 15, 17, 21, 23, 25, 27, 33 Lighting system

2 LED Array (Light Source)

3 24 Taper rod lens (taper-like transparent material)

4 28 Rod lens (transparent material)

5, 12, 12r, 12b, 26 Outgoing radiation lens (optical element)

6 52 Liquid crystal light valve (an illuminated field, optical modulator)

7 Substrate

8, 8R, 8G, 8B Chip LED (solid-state light emitting device)

18 Closure Layer

19 22 Mirror

29a, 29b Conductor pattern

30 Through Hole

31 Insulator Layer

41 51 Liquid crystal projector

44 Projector Lens

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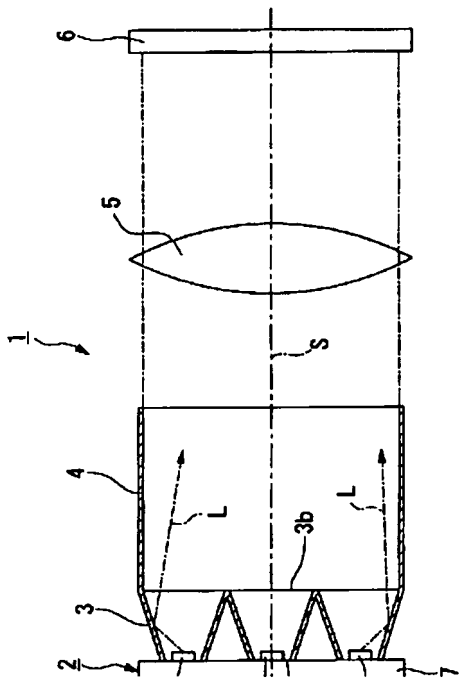
(54)【発明の名称】　照明装置および投射型表示装置

(57)【要約】
【課題】　照明効率の向上を図り得る照明装置、および明るく、高コントラストの表示が得られる投射型表示装置を提供する。
【解決手段】　本発明の投射型表示装置に用いられる照明装置１は、複数のチップＬＥＤ８Ｒ，８Ｇ，８Ｂを有するＬＥＤアレイ２と、各チップＬＥＤ８Ｒ，８Ｇ，８Ｂに対応して設けられた複数のテーパロッドレンズ３と、複数のテーパロッドレンズ３に共通のロッドレンズ４と、ロッドレンズ４から入射された光を所定の出射角度をもって出射させる出射レンズ５とが備えられている。



【特許請求の範囲】

【請求項１】　複数の固体発光素子を有する光源と、前記複数の固体発光素子の各々に対応して設けられ、前記固体発光素子からの光が入射端面から入射され出射端面から出射されるとともに前記入射端面の面積よりも前記出射端面の面積の方が大きい複数のテーパ状導光体と、前記テーパ状導光体から入射された光を所定の出射角度をもって出射させる光学素子とが備えられたことを特徴とする照明装置。

【請求項２】　前記テーパ状導光体が、屈折率が１以上の材料からなる柱状の導光体、もしくは内面が反射面とされた管状の導光体で構成されたことを特徴とする請求項１に記載の照明装置。

【請求項３】　前記テーパ状導光体の出射側に、入射光の照度分布を均一化する機能を有する導光体がさらに備えられたことを特徴とする請求項１または２に記載の照明装置。

【請求項４】　前記導光体が、入射端面の面積よりも出射端面の面積の方が大きいテーパ状とされたことを特徴とする請求項３に記載の照明装置。

【請求項５】　前記各テーパ状導光体の出射側に前記光学素子がそれぞれ備えられたことを特徴とする請求項１または２に記載の照明装置。

【請求項６】　前記各光学素子からの出射光が所定の出射角度を有し、複数の光学素子からの出射光が被照明領域において少なくとも一部重畳されることを特徴とする請求項５に記載の照明装置。

【請求項７】　システム光軸上から外れた位置にある前記固体発光素子に対応する前記光学素子が、前記固体発光素子の出射光軸に対して前記システム光軸寄りの位置に配置されていることを特徴とする請求項５または６に記載の照明装置。

【請求項８】　前記複数の固体発光素子が、各々の出射光軸が交差するように配置されていることを特徴とする請求項５または６に記載の照明装置。

【請求項９】　前記固体発光素子の少なくとも出射面に、透光性を有する封止層が設けられたことを特徴とする請求項１ないし８のいずれか一項に記載の照明装置。

【請求項１０】　前記封止層の側面が、光の出射方向に向けて先拡がりのテーパ形状とされたことを特徴とする請求項９に記載の照明装置。

【請求項１１】　前記封止層の側面が、前記封止層の内部を導光し前記側面に達した光を前記封止層側に反射させる反射面とされたことを特徴とする請求項１０に記載の照明装置。

【請求項１２】　前記複数の固体発光素子が基板の一面に設けられたことを特徴とする請求項１ないし１１のいずれか一項に記載の照明装置。

【請求項１３】　前記基板の前記一面と反対側の面に、前記基板を貫通するスルーホールを介して前記固体発光素子の外部端子が導出されていることを特徴とする請求項１２に記載の照明装置。

【請求項１４】　前記基板の前記実装面に、前記固体発光素子の外部端子の一部をなす導体が設けられ、前記導体が絶縁膜で覆われていることを特徴とする請求項１３に記載の照明装置。

【請求項１５】　前記絶縁膜上に前記テーパ状導光体が設けられていることを特徴とする請求項１４に記載の照明装置。

【請求項１６】　前記光源を構成する複数の固体発光素子が、異なる色の色光を発光する固体発光素子を含むことを特徴とする請求項１ないし１５のいずれか一項に記載の照明装置。

【請求項１７】　請求項１ないし１６のいずれか一項に記載の照明装置と、前記照明装置からの光を変調する光変調器と、前記光変調器により変調された光を投射する投射レンズとを少なくとも備えたことを特徴とする投射型表示装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、照明装置および投射型表示装置に関するものである。

【０００２】

【従来の技術】液晶ライトバルブ等の光変調器を用いて映像光を合成し、合成された映像光を投射レンズ等からなる投射光学系を通じてスクリーンに拡大投射する投射型表示装置が従来から知られている。この種の投射型表示装置に用いられる照明装置において、メタルハライドランプ等の光源から出射される光は通常、中央部が明るく、周縁部が暗いという不均一な照度分布を持っている。そこで、投射型表示装置用の照明装置には、被照明領域、具体的には液晶ライトバルブにおける照度分布を均一化するために、２枚のフライアイレンズからなるフライアイインテグレータ、もしくはロッド状導光体（以下、ロッドレンズと言うこともある）からなるロッドインテグレータ等の均一照明系が通常備えられている。また、光源自体も、面内で均一な照度が得られやすい面発光光源の採用が検討されている。

【０００３】

【発明が解決しようとする課題】従来、面発光光源を実現するには、例えば複数の発光ダイオード（Light Emitting Diode，以下、ＬＥＤと略記する）ランプを基板上にアレイ状に並べた、いわゆるＬＥＤランプアレイが提供されていた。ところが、従来のＬＥＤランプは、個々のＬＥＤが半球状に突出した樹脂レンズを備えており、これをアレイ状に並べると光源自体がかなり大型のものとなっていた。これに対して、近年、チップ型のＬＥＤ

た。

【０００４】しかしながら、チップＬＥＤは放射角度分布が大きいという特性を有しているため、被照明体を照明する際に照明効率が悪いという問題があった。また、投射型表示装置に用いた際に液晶ライトバルブ等の光変調器の入射面に対して斜め方向から入射する光の成分が多いため、表示が暗くなり、コントラストが低下する原因となっていた。

【０００５】本発明は、上記の課題を解決するためになされたものであって、照明効率の向上を図り得る照明装置を提供することを目的とする。また、明るく、高コントラストの表示が得られる投射型表示装置を提供することを目的とする。

【０００６】

【課題を解決するための手段】上記の目的を達成するために、本発明の照明装置は、複数の固体発光素子を有する光源と、前記複数の固体発光素子の各々に対応して設けられ、前記固体発光素子からの光が入射端面から入射され出射端面から出射されるとともに前記入射端面の面積よりも前記出射端面の面積の方が大きい複数のテーパ状導光体と、前記テーパ状導光体から入射された光を所定の出射角度をもって出射させる光学素子とが備えられたことを特徴とする。

【０００７】本発明の照明装置は、複数の固体発光素子を有する光源によって面発光光源が構成されているが、固体発光素子自体の放射角度分布が大きいため、この光源のみではそこから出射される光の放射角度分布は大きいままである。ところが、本発明では、光源の出射側に前記テーパ状導光体が備えられているので、固体発光素子からの光がテーパ状導光体の内部で反射する際にシステム光軸に対して平行に近い角度に曲げられることになり、放射角度分布を狭めることができる。さらに、テーパ状導光体の出射側に前記光学素子が備えられているので、テーパ状導光体から入射された光が所定の出射角度をもって出射され、その出射角度を適宜調整することで所定の被照明領域に対して効率が良く、より均一な照明を実現することができる。なお、「システム光軸」とは、照明装置全体としての出射光軸のことである。

【０００８】前記テーパ状導光体は、屈折率が１以上の材料からなる柱状の導光体、もしくは内面が反射面とされた管状の導光体で構成することができる。ここで言う「柱状の導光体」もしくは「内面が反射面とされた管状の導光体」は、いわゆる従来からあるロッドレンズである。この構成によれば、従来のロッドレンズを前記光源の出射側に設置するだけで、本発明の構成を容易に実現することができる。

【０００９】また、前記テーパ状導光体の出射側に、入射光の照度分布を均一化する機能を有する導光体をさらもよい。本発明においては、テーパ状導光体によって光の放射角度分布を狭めることができるが、その出射側に前記導光体を備えることによって照度分布をより均一化することができる。その結果、例えば表示装置の照明装置として用いた場合に表示の明るさムラを抑制することができる。さらにこの導光体をテーパ状とすれば、照度分布の均一化の効果を維持しながら、放射角度分布を狭める効果をより高めることが可能となる。

【００１０】前記テーパ状導光体の出射側に前記光学素子を設ける場合、複数のテーパ状導光体に対して１個の光学素子を設けてもよいし、個々のテーパ状導光体にそれぞれ光学素子を設けてもよい。特に後者の場合、各固体発光素子から出射される光束毎に出射角度を制御することができ、より効率の良い照明を行うことができる。

【００１１】特にテーパ状導光体毎に光学素子を設けた場合、各光学素子からの出射光が所定の出射角度を有し、複数の光学素子からの出射光が被照明領域において少なくとも一部重畳される構成とすることが望ましい。複数の光学素子からの出射光が被照明領域で一部重畳される構成とすることで各出射光が例えば中央が明るく、周辺が暗いというような照度分布を持っていたとしても、その照度分布が相殺され、全体として照度が均一な照明光を得ることができる。さらに、複数の光学素子からの出射光が被照明領域において全て重畳される構成とすれば、出射光間で輝度のバラツキがあった場合でもそのバラツキが相殺され、照度ムラのない照明光を得ることができる。

【００１２】また、システム光軸上から外れた位置にある固体発光素子に対応する光学素子は、固体発光素子の出射光軸に対してシステム光軸寄りの位置に配置することが望ましい。この構成によれば、光学素子からの出射光軸の向きがシステム光軸寄り、すなわち被照明領域の中心寄りに近付くので、光の無駄がなく、より効率の良い照明を提供することができる。

【００１３】あるいは、複数の固体発光素子を、例えば被照明領域を囲むように曲面状に配置するなどして、各々の出射光軸が交差するように構成することが望ましい。この構成とした場合、各々の出射光軸の交差点を被照明領域の中心に位置させれば、上記の場合と同様、光の無駄がなく、より効率の良い照明を提供することができる。

【００１４】さらに、固体発光素子の少なくとも出射面に、透光性を有する封止層を設けてもよい。この構成によれば、封止層を設けたことによって例えば機械的な衝撃や水分の浸入などから固体発光素子の出射面を保護することができ、信頼性を向上することができる。

【００１５】前記封止層の側面は、光の出射方向に向けて先拡がりのテーパ形状とすることが望ましい。その場

とが望ましい。封止層は透光性を有しているので、基本的には光の出射に支障が生じることはないが、固体発光素子の放射角度分布が大きいため、大きい放射角度で出射した光については封止層の表面で全反射してしまい、外部に出射されない恐れがある。そのような光が封止層内部を導光し、封止層の側面に達した場合、ここが光の出射方向に向けて先拡がりのテーパ形状であり、さらに反射面であれば、前記光が封止層の表面に対してより垂直に近い出射角度に変換されて反射されるので、光を外部に出射させ、照明に寄与させることができる。

【００１６】複数の固体発光素子はどのような形態で集積してもよいが、例えば任意の基板を用い、基板の一面に複数の固体発光素子を設置する構成とすることができる。この構成によれば、複数の固体発光素子を容易に集積することができ、光源の取り扱いも簡単になる。

【００１７】基板の一面に複数の固体発光素子を実装した場合、基板の固体発光素子実装面と反対側の面に、基板を貫通するスルーホールを介して固体発光素子の外部端子が導出された構成とすることが望ましい。従来の固体発光素子の実装形態は、基板等に固体発光素子の本体を実装するとともに、その実装面上でワイヤーボンディング等を用いて固体発光素子本体の外部に端子を導出していた。この形態であると、固体発光素子の本体の周囲にワイヤーボンディングのためのスペースが必要であり、また、ワイヤーとテーパ状導光体が干渉するなどして、テーパ状導光体の設置に支障が生じることがある。これに対して、上記の構成によれば、基板の固体発光素子実装面と反対側の面にスルーホールを介して固体発光素子の外部端子を導出しているので、実装面上のワイヤーボンディングが不要となり、実装作業が容易になるとともに、テーパ状導光体を支障なく設置することができる。

【００１８】基板の実装面に固体発光素子の外部端子の一部をなす導体を設けた場合、前記導体を絶縁膜で覆う構成とすることが望ましい。その場合、絶縁膜上にテーパ状導光体を設けることができる。この構成によれば、外部端子の一部をなす導体が他の部材と短絡する等の不具合を防止することができる。これにより、絶縁膜上にテーパ状導光体を設けることができ、例えば管状のテーパ状導光体であれば、これを固体発光素子に近接させて設置することができるため、固体発光素子からの出射光の利用効率を高めることができる。

【００１９】本発明の照明装置において、光源を構成する複数の固体発光素子が、異なる色の色光を発光する固体発光素子を含む構成としてもよい。この構成によれば、例えば色順次駆動（カラーシーケンシャル）方式のカラー投射型表示装置の照明装置として使用することができる。その場合、例えば各色光毎の３個のライトバルブ照明装置も１系統で済む。そして、色分離光学系や色合成光学系が不要となるため、部品点数を大きく削減できるとともに装置構成を簡単にでき、コスト低減を図ることができる。

【００２０】本発明の投射型表示装置は、上記本発明の照明装置と、前記照明装置からの光を変調する光変調器と、前記光変調器により変調された光を投射する投射レンズとを少なくとも備えたことを特徴とする。この構成によれば、上記本発明の照明装置を備えたことにより、照明装置から放射角度分布が狭く、照度分布が均一化された光が照射されるので、明るさムラが少なく、高コントラストの画像を再現することができる。

【００２１】

【発明の実施の形態】［第１の実施形態の照明装置］以下、本発明の第１の実施形態の照明装置を、図１を参照して説明する。本実施の形態では、光源を構成する固体発光素子としてチップＬＥＤを用いた例を示す。図１は照明装置１の全体構成を示す概略図であって、図中符号２はＬＥＤアレイ（光源）、３はテーパロッドレンズ（テーパ状導光体）、４はロッドレンズ（導光体）、５は出射レンズ（光学素子）である。なお、符号６は被照明体となる液晶ライトバルブ（光変調器）を示す。

【００２２】本実施の形態の照明装置１は、図１に示すように、例えばプリント基板等の任意の基板７の一面上に複数（図１では３個のみを示す）のチップＬＥＤ８Ｒ，８Ｇ，８Ｂが実装され、ＬＥＤアレイ２が構成されている。チップＬＥＤ８Ｒ，８Ｇ，８Ｂの実装形態については後の実施の形態で説明する。チップＬＥＤとしてはＲ（赤）の色光を発光可能なＬＥＤ８Ｒ、Ｇ（緑）の色光を発光可能なＬＥＤ８Ｇ、Ｂ（青）の色光を発光可能なＬＥＤ８Ｂが１枚の基板７上に搭載されている。

【００２３】そして、１個のチップＬＥＤ８Ｒ，８Ｇ，８Ｂに対して１個のテーパロッドレンズ３が対応して設けられている。本実施の形態では、内面が反射面となるように配置された管状のミラーからなるテーパロッドレンズ３が用いられている。その他、屈折率が１以上の材料、例えばガラス等の柱状体からなるテーパロッドレンズを用いてもよい。図２において、テーパロッドレンズ３の左側の面が入射端面３ａ、右側の面が出射端面３ｂとなっており、テーパロッドレンズ３は入射端面３ａ側から出射端面３ｂ側に向けて先拡がりのテーパ状の形状となっている。

【００２４】複数のテーパロッドレンズ３の出射側に１個のロッドレンズ４が設けられている。本実施の形態では、ロッドレンズ４も内面が反射面となるように配置された管状のミラーで構成されている。そして、複数のテーパロッドレンズ３の最外周のミラーとロッドレンズ４のミラーとが直接接続されている。さらに、ロッドレン

【００２５】本実施の形態の照明装置１においては、複数のチップＬＥＤ８Ｒ，８Ｇ，８Ｂを有するＬＥＤアレイ２の出射側にテーパロッドレンズ３が備えられているので、チップＬＥＤ８Ｒ，８Ｇ，８Ｂからの光がテーパロッドレンズ３の内部を導光する間に内面で反射し、システム光軸Ｓに対して平行に近い角度の光Ｌが得られ、放射角度分布を狭めることができる。そして、テーパロッドレンズ３の出射側にロッドレンズ４が備えられているので、照度分布を均一化することができる。さらに、ロッドレンズ４の出射側に出射レンズ５が備えられているので、出射レンズ５に入射された光が所定の出射角度をもって出射され、その出射角度を適宜調整することで液晶ライトバルブ６に対して効率良く、均一な照明を実現することができる。その結果、例えば投射型表示装置の照明装置として用いた場合に、照明効率の向上、コントラストの向上、表示の明るさムラの抑制を図ることができる。

【００２６】また、被照明体となる液晶ライトバルブ６の外径に対してロッドレンズ４の出射端面の外径を小さく設定し、拡大照明光学系とした場合、液晶ライトバルブ６に光が入射する際の入射角度は拡大率に反比例するため、液晶ライトバルブ６への入射角度を小さくすることができ、照明効率がより向上するのと同時にコントラストもより向上する。

【００２７】［第２の実施形態の照明装置］以下、本発明の第２の実施形態の照明装置を、図２～図４を参照して説明する。図２は本実施形態の照明装置の全体構成を示す概略図であるが、第１の実施形態と同一の構成要素には同一の符号を付し、詳細な説明は省略する。

【００２８】本実施形態の照明装置１１は、図２に示すように、基板７の一面上に複数のチップＬＥＤ８Ｒ，８Ｇ，８Ｂが実装され、ＬＥＤアレイ２が構成されている。そして、１個のチップＬＥＤ８Ｒ，８Ｇ，８Ｂに対して１個のテーパロッドレンズ３が対応して設けられている。ここまでの構成は第１の実施形態とほぼ同様である。第１の実施形態ではテーパロッドレンズ３の出射側にロッドレンズ４、出射レンズ５が順次設置されていたのに対し、本実施形態ではロッドレンズがなく、各テーパロッドレンズ３の出射端面に通常の凸レンズからなる出射レンズ１２が直接設置されている。テーパロッドレンズ３の内部空間は空気が存在していてもよいし、出射レンズ１２よりも低屈折率の材料が充填されていてもよい。そして、各出射レンズ１２から出射される出射光Ｌは液晶ライトバルブ６の全面において全て重畳されるように、各出射レンズ１２からの出射光Ｌの出射角度が設定されている。

【００２９】本実施形態においても、液晶ライトバルブ６に対して効率良く、均一な照明を実現することができるといった第１の実施形態と同様の効果を得ることができる。

【００３０】さらに本実施の形態の場合、個々のテーパロッドレンズ３にそれぞれ出射レンズ１２が設けられているので、各チップＬＥＤ８Ｒ，８Ｇ，８Ｂから出射される光束毎に出射角度を制御することができ、より効率の良い照明を行うことができる。具体的には、各出射レンズ１２から出射される出射光が液晶ライトバルブ６の全面において全て重畳されるようにするために、例えば図３に示すように、システム光軸Ｓ上から外れた位置にあるチップＬＥＤ８Ｒ，８Ｂに対応する出射レンズ１２Ｒ，１２Ｂの中心Ｃ１を、各チップＬＥＤ８Ｒ，８Ｂの出射光軸Ｃ２に対してシステム光軸Ｓ寄りの位置に配置すればよい。あるいは、図４に示すように、複数のチップＬＥＤ８Ｒ，８Ｇ，８Ｂを、液晶ライトバルブ６を囲むように曲面状に配置し、各々のチップＬＥＤ８Ｒ，８Ｇ，８Ｂからの出射光軸Ｃ３が液晶ライトバルブ６の略中心で交差するように構成してもよい。複数のチップＬＥＤ８Ｒ，８Ｇ，８Ｂからの出射光が液晶ライトバルブ６上で一部重畳されるだけで各出射光の中央が明るく、周辺が暗いという照度分布を相殺することができるが、本実施の形態の場合、複数のチップＬＥＤ８Ｒ，８Ｇ，８Ｂからの出射光が液晶ライトバルブ６上で全て重畳されるので、複数のチップＬＥＤ８Ｒ，８Ｇ，８Ｂ間で輝度バラツキがあった場合でもそのバラツキが相殺され、照度ムラのない照明光を得ることができる。

【００３１】［第３の実施形態の照明装置］以下、本発明の第３の実施形態の照明装置を、図５～図９を参照して説明する。図５は本実施形態の照明装置の全体構成を示す概略図であるが、第１の実施形態と同一の構成要素には同一の符号を付し、詳細な説明は省略する。

【００３２】本実施形態の照明装置１７は、図５に示すように、基板７の一面上に複数のチップＬＥＤ８Ｒ，８Ｇ，８Ｂが実装され、ＬＥＤアレイ２が構成されている。そして、複数のチップＬＥＤ８Ｒ，８Ｇ，８Ｂが例えばアクリル樹脂等の透光性を有する材料で封止され、封止層１８が形成されている。封止層１８の側面１８ａは平面状でかつ光の出射方向に向けて先拡がりのテーパ形状とされ、側面１８ａには内面が反射面とされたミラー１９が設置されている。

【００３３】本実施形態の場合、封止層１８は透光性を有しているので、基本的には光の出射に支障が生じることはない。しかしながら、チップＬＥＤ８Ｒ，８Ｇ，８Ｂの放射角度分布が大きいため、大きい放射角度で出射した光については封止層１８の表面で全反射してしまい、封止層１８の外部に出射されない恐れがある。この対策として、封止層１８の側面が光の出射方向に向けて先拡がりのテーパ形状であり、さらにミラー１９による

角度に変換されるので、封止層１８の外部に出射し、照明に寄与することができる。

【００３４】図５では封止層１８の側面１８ａを平面状としたが、この構成に代えて、図６に示すように、封止層１８の側面１８ｂを曲面状としてもよい。このようにして、封止層１８の側面で反射した光の封止層外部への出射角度を適宜調節することができる。

【００３５】また図７に示すように、図５に示した照明装置１７の封止層１８の出射側に、テーパロッドレンズ２４をさらに付加してもよい。これにより、この照明装置２３からの出射光の放射角度分布をより狭めることができる。また、図７に示した照明装置２３のテーパロッドレンズ２４の出射側に、図８に示すように出射レンズ２６を直接設置してもよいし、図９に示すようにロッドレンズ２８を直接設置してもよい。

【００３６】［第４の実施形態の照明装置］以下、本発明の第４の実施形態の照明装置を、図１０、図１１を参照して説明する。上記実施形態では照明装置の全体構成について説明したが、本実施形態ではチップＬＥＤの実装構造について説明する。図１０は本実施形態のチップＬＥＤの実装構造を示す断面図である。

【００３７】本実施形態のチップＬＥＤ８の実装構造は、図１０に示すように、基板７の上面に、光出射面が上側、電極形成面が下側となるように表面実装型のチップＬＥＤ本体８ａが実装されている。本実施の形態における基板７は例えば両面プリント配線板のようなものであり、上面および下面に導体パターン２９ａ，２９ｂが形成され、これら導体パターン２９ａ，２９ｂが基板７を貫通するスルーホール３０を介して電気的に接続されている。そして、基板７上面の２つの導体パターン２９ａにチップＬＥＤ本体８ａ下面側の正極および負極がそれぞれ接続されている。この構成によって、チップＬＥＤ８の外部端子が基板７の実装面とは反対側の面に導出されている。また、基板上面の導体パターン２９ａは例えばレジスト膜等の絶縁膜３１で覆われており、その絶縁膜３１上にテーパロッドレンズ３が設置されている。

【００３８】従来のチップＬＥＤの実装形態は、基板等にチップＬＥＤ本体を実装するとともに、その実装面上でワイヤーボンディング等を用いて電極から外部端子を導出していた。この形態であると、チップＬＥＤ本体の周囲にワイヤーボンディング用のスペースが必要であり、テーパロッドレンズの設置に支障が生じることがある。これに対して、本実施形態の構成によれば、基板７のチップＬＥＤ８の実装面と反対側の面にスルーホール３０を介して外部端子を導出しているので、実装面上のワイヤーボンディングが不要となり、高密度実装化を図ることができる。また、基板上面の導体パターン２９ａが絶縁膜３１で覆われており、絶縁膜３１上にテーパロッドレンズ３をチップＬＥＤ８に近接させて設置することができる。その結果、チップＬＥＤ８からの出射光の利用効率を高めることができる。

【００３９】また、図１１に示すように、図１０で示した照明装置３３のチップＬＥＤ８および絶縁膜３１の上面を図５～図９で示したのと同様の封止層１８で覆うようにしても良い。これにより、チップＬＥＤ８や導体パターン２９ａを確実に保護することができる。

【００４０】なお、本発明の技術範囲は上記実施の形態に限定されるものではなく、本発明の趣旨を逸脱しない範囲において種々の変更を加えることが可能である。例えば上記実施形態では、光源を構成する固体発光素子としてＬＥＤを用いたが、この他、例えば半導体レーザ、エレクトロルミネッセンス素子等を用いることができる。また、被照明体への出射角度を制御する光学素子として通常の凸レンズを用いたが、この他、フレネルゾーンプレート等の非球面レンズ、ホログラム、回折素子などを用いることができる。

【００４１】［第１の実施形態の投射型表示装置］以下、本発明の第１の実施形態の投射型表示装置を、図１２を参照して説明する。本実施形態の投射型表示装置は、光変調器として透過型液晶ライトバルブを用いた透過型液晶プロジェクタの例である。図１２は本実施形態の液晶プロジェクタの概略構成図である。

【００４２】本実施形態の液晶プロジェクタ４１は、図１２に示すように、図１に示した第１の実施形態の照明装置１と液晶ライトバルブ６とを有している。すなわち、Ｒ、Ｇ、Ｂの各色光を出射可能な複数のチップＬＥＤ８Ｒ，８Ｇ，８Ｂが平面状に配列されたＬＥＤアレイ２と、チップＬＥＤ８Ｒ，８Ｇ，８Ｂに対応して設置された複数のテーパロッドレンズ３と、複数のテーパロッドレンズ３に対して共通に設けられたロッドレンズ４と、出射レンズ５と、出射レンズ５から入射される各色光を変調して画像を合成する液晶ライトバルブ６と、液晶ライトバルブ６によって合成された画像をスクリーン４３に拡大投射する投射レンズ４４とから概略構成されている。なお、より光の利用効率を高めるために、チップＬＥＤ８Ｒ，８Ｇ，８Ｂからの光を液晶ライトバルブ６で表示に用いる偏光に揃えるＰＢＳ（偏光ビームスプリッタ）アレイを備える構成としてもよい。

【００４３】ＬＥＤアレイ２は図示しない光源駆動回路に接続されており、この光源駆動回路によって各ＬＥＤ８Ｒ，８Ｇ，８Ｂが発光するタイミングが制御され、各ＬＥＤ８Ｒ，８Ｇ，８Ｂから例えばＲ、Ｇ、Ｂ、Ｒ、Ｇ、Ｂ、…というように時間順次に色光を発光可能な構成となっている。

【００４４】液晶ライトバルブ６には、画素スイッチン

クティブマトリクス方式の透過型の液晶セル４５が使用され、液晶セル４５の外面には入射側偏光板４６、出射側偏光板４７がその透過軸が互いに直交するように配置されて設けられている。例えば、オフ状態では液晶ライトバルブ６に入射されたｓ偏光がｐ偏光に変換されて出射される一方、オン状態では光が遮断されるようになっている。

【００４５】液晶ライトバルブ６は図示しない液晶ライトバルブ駆動回路に接続されており、この液晶ライトバルブ駆動回路によって、入射される各色光に対応させて液晶ライトバルブ６を時間順次に駆動することが可能な構造になっている。また、本実施の形態の投射型表示装置４１においては、図示しない同期信号発生回路が備えられており、この同期信号発生回路により、同期信号を発生させ、光源駆動回路および液晶ライトバルブ駆動回路に入力することにより、各ＬＥＤ８Ｒ，８Ｇ，８Ｂから色光を出射するタイミングと、その色光に対応して液晶ライトバルブ６を駆動するタイミングとを同期させることができる構造になっている。

【００４６】すなわち、本実施の形態の投射型表示装置４１では、１フレームを時分割し、ＬＥＤ７ｒ，７ｇ，７ｂから時間順次にＲ、Ｇ、Ｂの各色光を出射させ、各ＬＥＤ７ｒ，７ｇ，７ｂから色光を出射するタイミングと液晶ライトバルブ５を駆動するタイミングとを同期させることにより、各ＬＥＤ７ｒ，７ｇ，７ｂから出射される色光に対応させて液晶ライトバルブ５を時間順次に駆動し、各ＬＥＤ７ｒ，７ｇ，７ｂから出射される色光に対応する画像信号を出力することにより、カラー画像を合成することが可能な構成になっている。

【００４７】本実施の形態の投射型表示装置４１は、いわゆる「色順次駆動（カラーシーケンシャル）方式」と呼ばれる駆動方式を採用したものである。したがって、各色光毎の３個の液晶ライトバルブを用いる従来の３板方式の投射型表示装置と異なり、液晶ライトバルブ６が１個で済み（単板方式となる）、さらに液晶ライトバルブ６への照明装置１も１系統で済む。そして、色分離光学系や色合成光学系が不要となるため、部品点数を大きく削減できるとともに装置構成を簡単にでき、コスト低減を図ることができる。また、照明装置１から放射角度分布が狭く、照度分布が均一化された光が液晶ライトバルブ６に照射されるので、明るさムラが少なく、高コントラストの画像を再現することができる。

【００４８】［第２の実施形態の投射型表示装置］以下、本発明の第２の実施形態の投射型表示装置を、図１３を参照して説明する。本実施形態の投射型表示装置は、光変調器として反射型液晶ライトバルブを用いた反射型液晶プロジェクタの例である。図１３は本実施形態の液晶プロジェクタの概略構成図である。

装置１１と液晶ライトバルブ５２とを有している。すなわち、Ｒ、Ｇ、Ｂの各色光を出射可能な複数のチップＬＥＤ８Ｒ，８Ｇ，８Ｂが平面状に配列されたＬＥＤアレイ２と、チップＬＥＤ８Ｒ，８Ｇ，８Ｂに対応して設置された複数のテーパロッドレンズ３と、各テーパロッドレンズ３の出射端面に設けられた出射レンズ１２と、出射レンズ１２から入射される各色光を変調して画像を合成する液晶ライトバルブ５２と、液晶ライトバルブ５２によって合成された画像をスクリーン４３に拡大投射する投射レンズ４４とから概略構成されている。液晶ライトバルブ５２には、ＴＦＴを用いたＴＮモードのアクティブマトリクス方式の反射型液晶セル５３が使用され、偏光板５４が設けられている。

【００５０】本実施形態の液晶プロジェクタ５１においても、上記実施形態の照明装置１１を備えたことで明るさムラが少なく、高コントラストの画像を再現することができる、といった第１の実施形態の液晶プロジェクタと同様の効果を得ることができる。

【００５１】なお、本発明の技術範囲は上記実施の形態に限定されるものではなく、本発明の趣旨を逸脱しない範囲において種々の変更を加えることが可能である。例えば上記実施の形態では１つの照明装置の中に赤色光、緑色光、青色光を出射可能なＬＥＤを混在させた単板方式の色順次駆動の液晶プロジェクタの例を挙げたが、赤色光、緑色光、青色光を出射可能な照明装置を３系統設け、クロスダイクロイックプリズム等の色合成光学系を備えた３板方式の液晶プロジェクタとしてもよい。あるいは、白色光を出射可能な１つの照明装置を備え、ダイクロイックミラー等の色分離光学系、クロスダイクロイックプリズム等の色合成光学系を備えた３板式の液晶プロジェクタとしてもよい。さらに、上記実施形態では本発明の照明装置を投射型表示装置に用いた例を示したが、直視型の表示装置に用いることもできる。

【００５２】

【発明の効果】以上、詳細に説明したように、本発明の照明装置によれば、被照明領域に対して効率が良く、より均一な照明を実現することができる。また、本発明の投射型表示装置によれば、照明装置から放射角度分布が狭く、照度分布が均一化された光が照射されるので、明るさムラが少なく、高コントラストの画像を再現することができる。

【図面の簡単な説明】

【図１】　本発明の第１の実施形態の照明装置を示す概略構成図である。

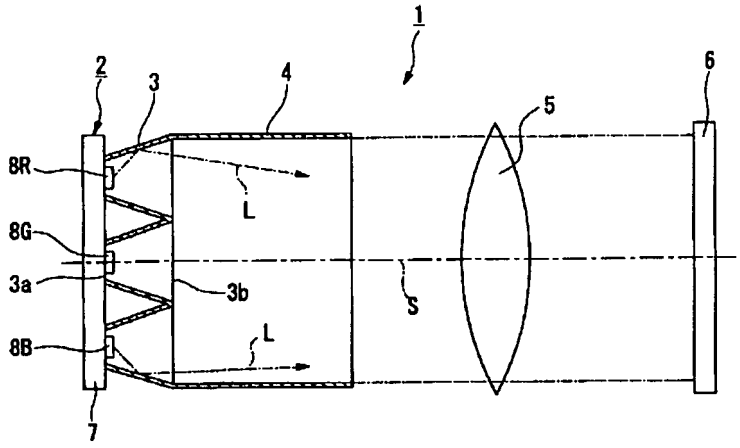
【図２】　本発明の第２の実施形態の照明装置を示す概略構成図である。

【図３】　同、照明装置の出射レンズの変形例を示す概略構成図である。

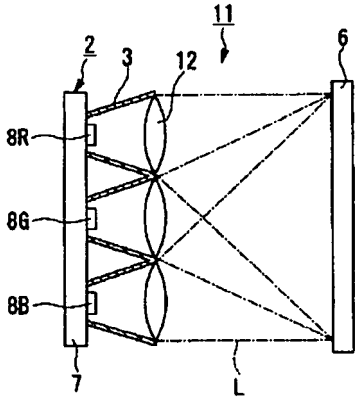
【図５】　本発明の第３の実施形態の照明装置を示す概略構成図である。
【図６】　同、照明装置の封止層の側面形状の変形例を示す概略構成図である。
【図７】　同、照明装置の変形例を示す概略構成図である。
【図８】　同、照明装置の変形例を示す概略構成図である。
【図９】　同、照明装置の変形例を示す概略構成図である。
【図１０】　本発明の第４の実施形態の照明装置を示す概略構成図である。
【図１１】　同、照明装置の変形例を示す概略構成図である。
【図１２】　本発明の第１の実施形態の投射型表示装置である液晶プロジェクタの概略構成図である。
【図１３】　本発明の第２の実施形態の投射型表示装置である液晶プロジェクタの概略構成図である。

【符号の説明】
１，１１，１３，１５，１７，２１，２３，２５，２７，３３　照明装置
２　ＬＥＤアレイ（光源）
３，２４　テーパロッドレンズ（テーパ状導光体）
４，２８　ロッドレンズ（導光体）
５，１２，１２ｒ，１２ｂ，２６　出射レンズ（光学素子）
６，５２　液晶ライトバルブ（被照明領域、光変調器）
７　基板
８，８Ｒ，８Ｇ，８Ｂ　チップＬＥＤ（固体発光素子）
１８　封止層
１９，２２　ミラー
２９ａ，２９ｂ　導体パターン
３０　スルーホール
３１　絶縁膜
４１，５１　液晶プロジェクタ
４４　投射レンズ

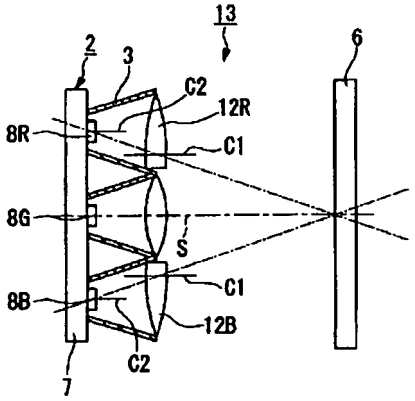
【図１】



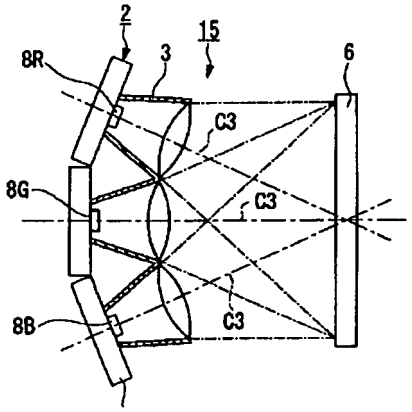
【図２】



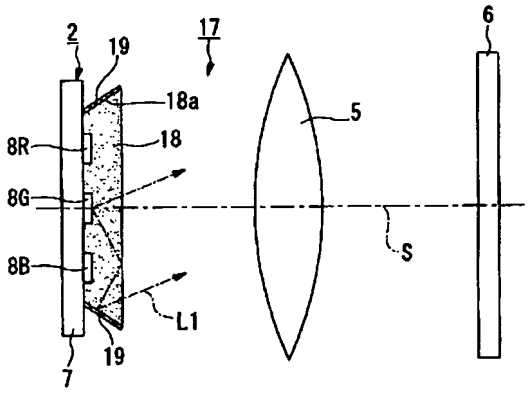
【図３】



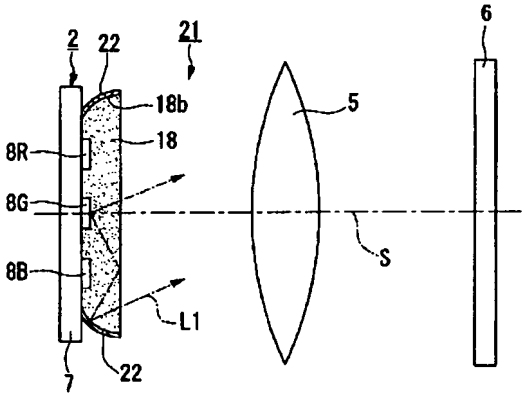
【図４】



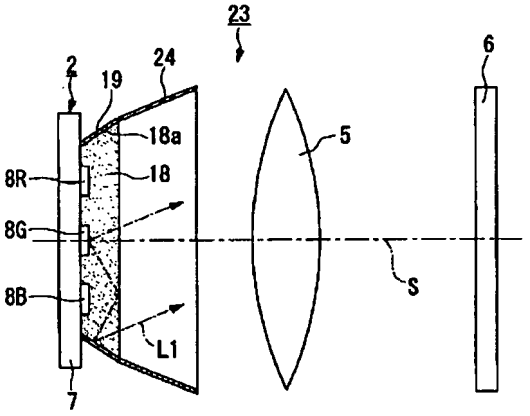
【図５】



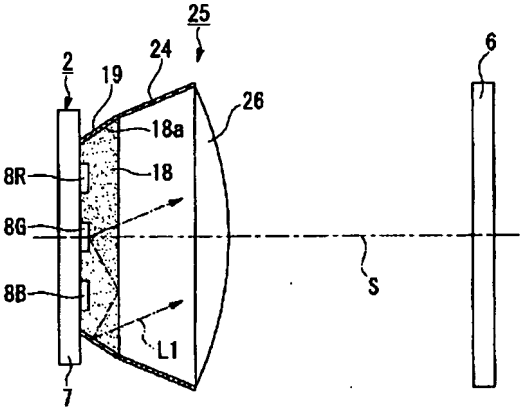
【図６】



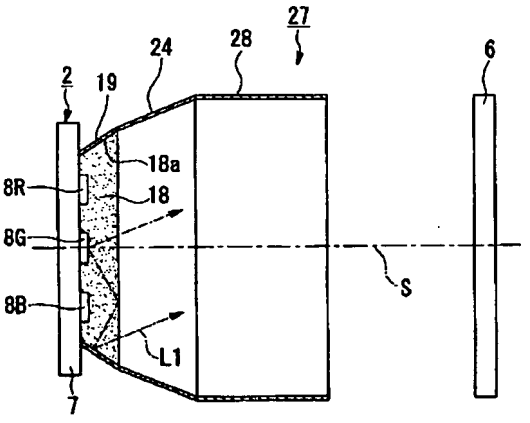
【図７】



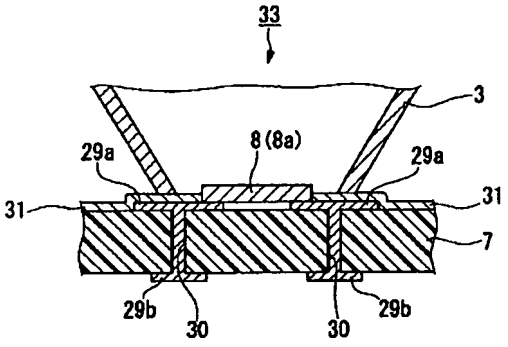
【図８】



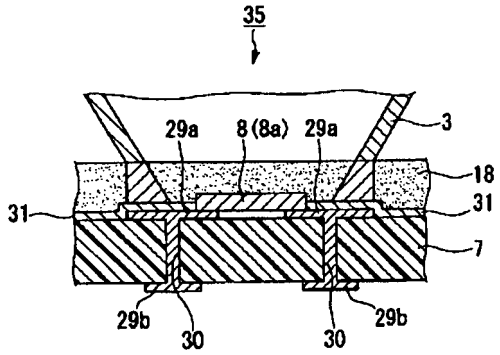
【図９】



【図１０】



【図１１】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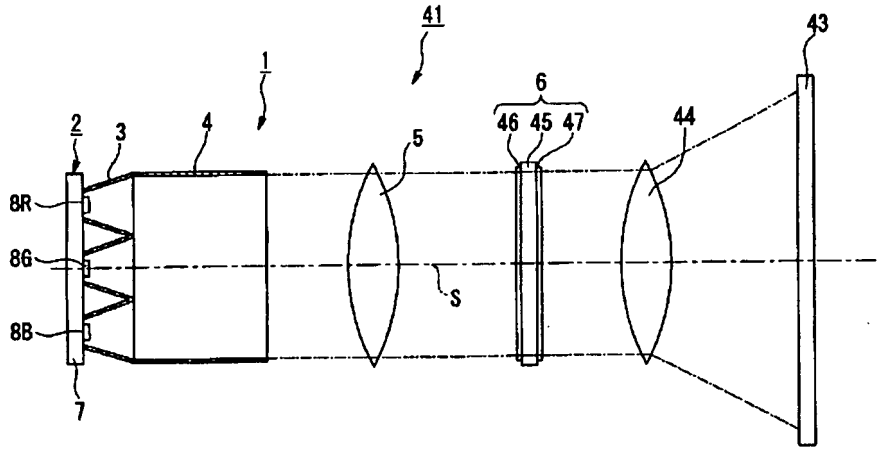
8(8a)
29a
3
18
31
31
7
29b
30
30
29b

【図１２】


41
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6
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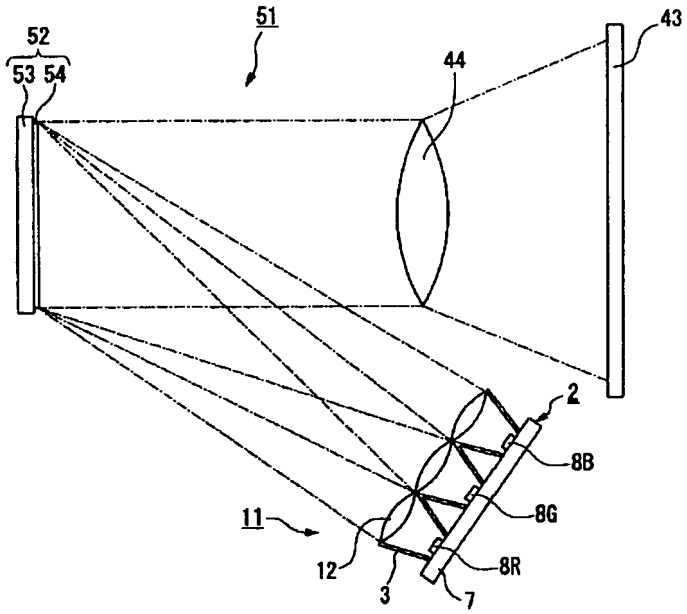
44
43
8R
8G
8B
S
7

【図１３】


51
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8B
8G
8R
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12
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7

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			F21M	1/00	R

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5F041 AA06 DA13 DA14 DA36 DA43
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